Precision Measurement of μp Capture in Hydrogen

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The goal of this experiment is a high precision measurement ($\pm$ 1 %) of the muon capture rate Λ_s from the 1s-singlet state on the proton. This rate is very sensitive to the weak form factors of the nucleon. In particular it allows a determination of the induced pseudoscalar coupling constant g_p, a quantity which is poorly known and presently under discussion due to experiments. Consequently, a precise measurement is needed to clarify the experimental situation, and to rigorously test modern theoretical approaches in low-energy QCD effective field theories which have already reached a precision far beyond the experiment.

Our efforts aim to avoid the systematic errors and problems of former experiments. The experiment is based on an extremely precise measurement of the muon lifetime in the μ^-p system (to $\pm$10 ppm), which is compared with the lifetime of the free μ^+ (measured with the same apparatus). The difference of the respective decay rates then determines the capture rate.

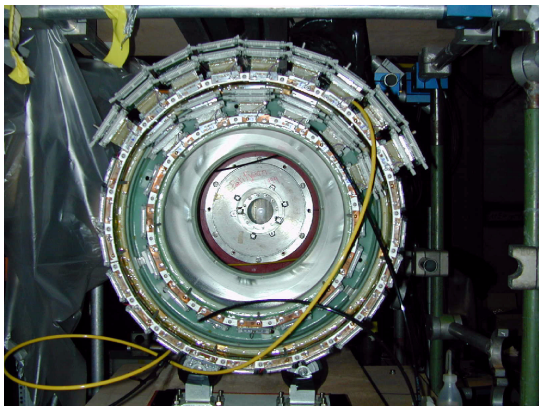

Figure 1: "MuCAP" setup: The two wire chambers used for electron tracking in front of PSI's muon channel.

A further description of the experiment and its main detectors can be found in last years' reports. This year's full effort was given to an engineering run, where we tested the tracking ability of the two wire chambers, the performance of the specially designed quartz-glass framed wire chambers in ultra-pure protium, the control of systematic effects due to muon spin rotation of the μ^+, and the full DAQ for the experiment.

Fig.1 shows the setup in-front of the μE4 beam line at the Paul Scherrer Institute (PSI).

Fig.2 shows the time spectrum of positrons from μ^+ decay obtained in the hodoscope detector atop of the setup, and the distortions due to the use of a pileup protection window (data neglected a second muon stop within $\pm$10 μs of a "good" muon stop). 2b shows the muon polarization alternating smoothly between top and bottom detectors after correction for the muon decay time. The residuals of the fit (Fig.2c) show that we have successfully decoupled the μSR effect from the lifetime.

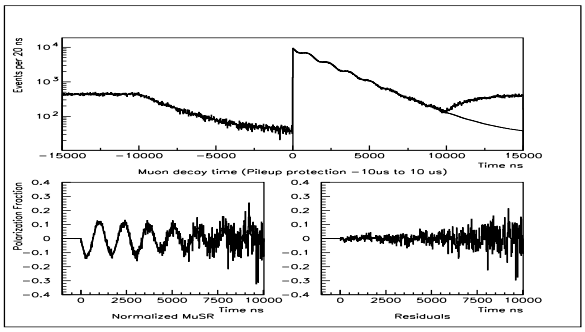

Figure 2: a) Time spectrum of hodoscope hits; b) "Pure" μSR effect after correction for the muon lifetime; c) Residuals of the fit.

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